European Space Agency
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OasISS

Second long-duration mission to the International Space Station

European prepares to command Space Station

ESA astronaut Frank De Winne will fly to the International Space Station (ISS) this spring at the start of a six month European mission called OasISS.

De Winne, of Belgian nationality and a member of the European Astronaut Corps, will also become the first European commander of the Space Station in October 2009.

He will conduct scientific experiments for scientists from different European countries, perform technology demonstrations and an extensive education programme aimed at inspiring students and children.

De Winne will also be instrumental in operating the Space Station's robotic arm and that of the Japan's Kibo module, helping with the latter to install external science and technology experiments on the Japanese laboratory.

OasISS, the second European long-duration mission to the ISS, will enlarge the permanent Space Station crew to six astronauts for the first time and thereby increase the time available for scientific work.

It is also for the first time that astronauts from all international partners will be onboard the ISS – representing the United States, Russia, Europe, Japan and Canada.

This will be De Winne's second mission to the Space Station on behalf of ESA following his successful 11 day 'Odissea' flight in 2002.

He is again due to be launched into orbit aboard the Russian Soyuz spacecraft (TMA-15) together with fellow new ISS Expedition crew members – Canadian Space Agency astronaut Robert Thirsk and Russian cosmonaut Roman Romanenko.

Their arrival on the ISS marks the beginning of a permanent crew of six onboard the Space Station. They will join the other three Expedition crew members already on the Space Station – Russian cosmonaut Gennady Padalka, NASA astronaut Michael Barratt and Koichi Wakata from the Japanese Aerospace Exploration Agency (JAXA).

Padalka and Barratt arrived as Expedition 19 crew members on Soyuz TMA-14 at the end of March. Wakata arrived on Shuttle flight STS-119 earlier in March.

Frank De Winne, who will initially assume the tasks of an ISS flight engineer, will be the third ESA astronaut to be a member of an ISS Expedition crew. He follows Thomas Reiter (Astrolab, 4 July – 22 December 2006) and Léopold Eyharts (Columbus, 7 February – 27 March 2008).

So far 13 European astronauts have worked on the ISS since 2001. De Winne will be one of the two operators of the Station's robotic arm when it is used for docking the first Japanese H-II Transfer Vehicle (HTV-1) to the ISS in September 2009.

In October De Winne will become commander of the ISS Expedition 21 crew, taking over the responsibilities from the Expedition 19 and 20 commander, Russian cosmonaut Gennady Padalka.

Among his responsibilities will be the oversight of all operations on the ISS, directing the activities of the ISS crew members as a single, integrated team, ensuring the safety of the crew, and the protection of the ISS elements, equipment and payloads.

Until now the ISS was only able to support a permanent crew of three. But with the recent addition of new solar power arrays and other environmental and life support systems, together with support from logistics spacecraft, a six member crew is possible.

The logistics spacecraft include the European Automated Transfer Vehicle (ATV), the Russian Progress spacecraft, the Japanese H-II Transfer Vehicle (to be launched for the first time during the OasISS mission) and the Space Shuttle.

A six person crew increases the time available for Frank De Winne and his international colleagues to carry out important scientific, medical and technological research, as well as their standard operational tasks.

"The OasISS mission is a visible sign of the increasing role that Europe is playing through ESA in human spaceflight," said Simonetta Di Pippo, ESA Director of Human Spaceflight. The experience gained will provide a sound basis for future human exploration missions," she added.

Frank De Winne will fly on a Russian Soyuz rocket, similar to the launch pictured above.

Frank De Winne training for his second stint on the ISS.

ESA to participate in more ISS missions

Frank De Winne will be joined onboard the International Space Station (ISS) by Swedish ESA astronaut Christer Fuglesang, who will fly as mission specialist on the 11 day STS-128 Space Shuttle mission scheduled for August 2009.

As part of his flight Fuglesang will be undertaking spacewalks to carry out ISS assembly and maintenance work, as he did in 2006 as a mission specialist on the Celsius/STS-116 Shuttle mission.

After De Winne's flight, the next European long-term mission will be that of Italian ESA astronaut Paolo Nespoli who will assume the role of flight engineer on Expeditions 26 and 27. His launch is due in November 2010 and he will return to Earth half a year later in May 2011.

It will be the second mission to space for Nespoli. In October 2007 he flew on Space Shuttle flight STS-120 to deliver and install the European-built Node 2 to the ISS.

Node 2, now called 'Harmony', is the interconnecting module to which the European Columbus space laboratory was attached in February 2008.

Nespoli was instrumental in orchestrating four spacewalks from inside the Space Shuttle and the ISS, to support ongoing construction of the Space Station.

OasISS name reflects importance of water

The name for ESA's second long-duration flight on the International Space Station (ISS) was chosen from more than 500 ideas received in response to a European-wide competition.

OasISS refers to many aspects of the Space Station as well as to human exploration – from the exploration of deserts on Earth by European explorers, to the deserts waiting to be found on other planets, where humankind might be able to set up an 'oasis' and provide a permanent human outpost.

The ISS itself can be considered an oasis in space for its astronauts and cosmonauts, whilst the Earth is often referred to as the 'Blue Planet' and represents an oasis for humankind.

The name also ties in with Frank De Winne's support of the UNICEF 2009 WASH campaign – dedicated to water, sanitation and hygiene. Several events will be implemented during his flight to draw public attention to the availability and cleanliness of water, which is critically important for human life.

"Water is a scarce resource onboard the ISS," said De Winne. "Its responsible use and recycling in space can help develop efficient water processing applications for use on Earth, which are particularly important for the developing countries."

Christer Fuglesang is currently training for more spacewalks similar to the one he is pictured on here during his 2006 Space Shuttle mission.

Europe contributes major parts of the Space Station

Hardware developed and built in Europe will have been launched on almost half of the assembly and construction missions when the International Space Station reaches completion at the end of 2010.

To achieve this ESA has united the best of Europe's skills, scientific and technical knowledge, contributing some of the Space Station's most important elements for the American, Japanese and Russian laboratories as well as on Europe's own laboratory, Columbus.

Columbus

A science laboratory giving Europe the opportunity to work at the cutting edge of scientific and technological research starting from 2008.

During a lifespan of at least a decade, Earth-based researchers – sometimes with assistance from the ISS crew – will conduct thousands of experiments in life sciences, materials science, fluid physics and a whole host of other disciplines, all in the weightlessness of orbit.

To keep costs low and reliability high, Columbus shares its basic structure and life-support systems with the Italian Space Agency's Multi-Purpose Logistics Modules (MPLM).

MPLMs – aptly described as a 'space moving van' – are carried in the Space Shuttle to transport specific equipment and provide extra temporary working space. The 75 cubic metres of space inside Columbus contains an entire suite of science laboratories.

Automated Transfer Vehicle (ATV)

A transport vehicle launched by Europe's Ariane-5 to carry propellant, food and other supplies. The successful flight of the first ATV, named Jules Verne, took place in 2008. In the future ATVs will be launched by an Ariane-5 at about 18 month intervals. The second ATV named after the German astronomer Johannes Kepler will be launched in late 2010.

European Robotic Arm (ERA)

Planned for the maintenance and assembly of Russian ISS elements. Operated from either inside or outside the Space Station, the 11.3 m long arm can manoeuvre equipment weighing up to 8000 kg.

Nodes 2 and 3

These are cylindrical elements similar in design and size to the Columbus laboratory. They provide important resources for connecting and operating other Space Station elements, as well as water processing and oxygen generation for the US segment and stowage for equipment racks. The first, Harmony, was launched in 2007 and the second, Tranquillity, follows in early 2010.

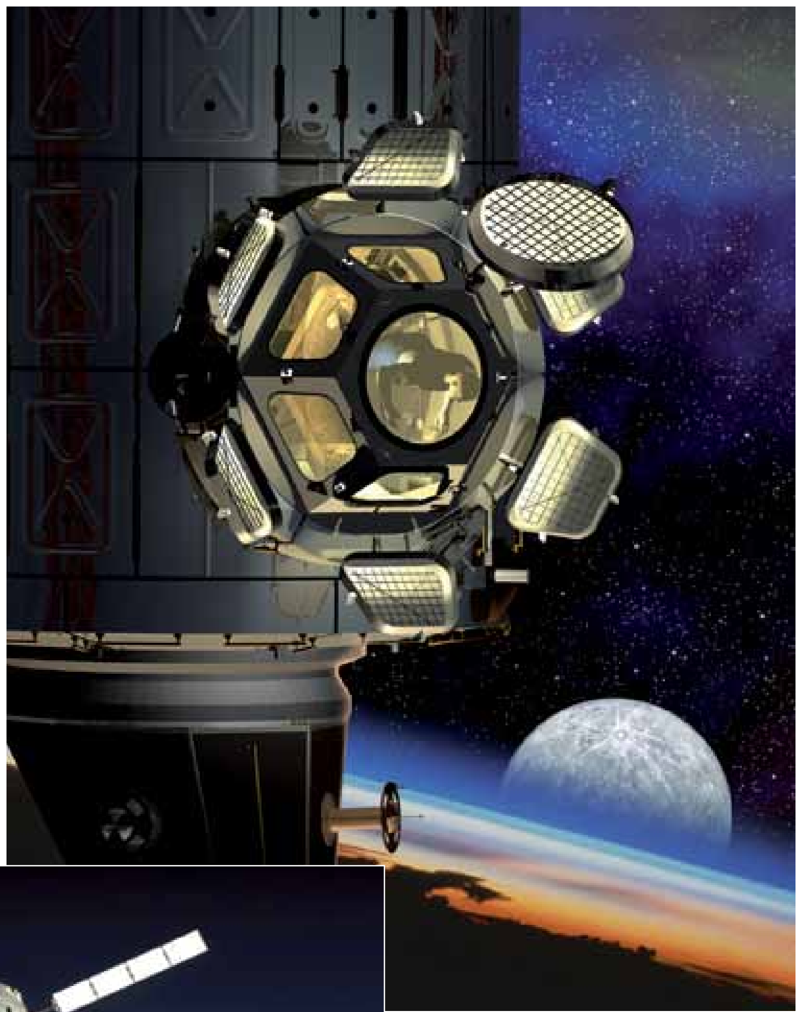
Data Management System (DMS-R)

The 'brain' of Russia's Zvezda module, which was launched in July 2000. The system performs overall control of the Russian elements, as well as guidance and navigation for the Space Station.

Cupola

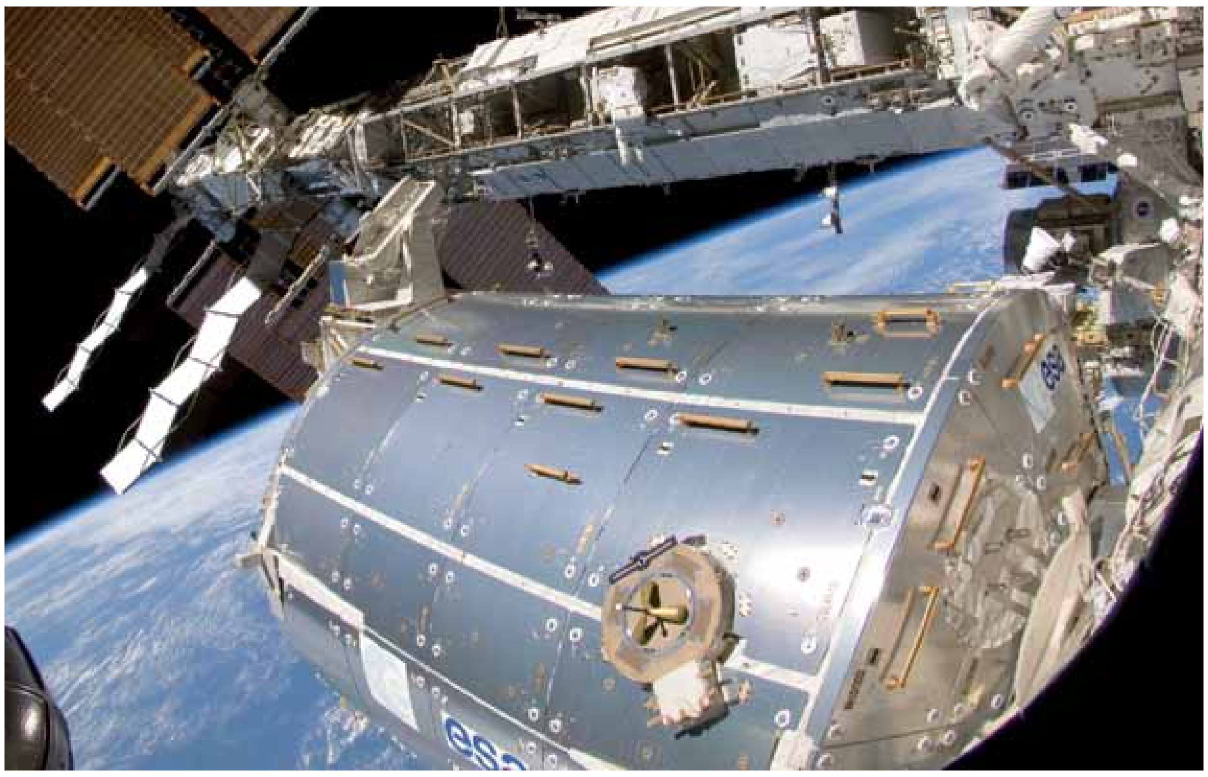
The ESA-built Cupola observation and control tower for the ISS is awaiting launch and promises to be a room with the most stunning view ever.

Once attached to Node 3 in early 2010 it will provide orbiting astronauts with a panoramic view point for guiding operations outside the Space Station and watching the Earth, as well as accommodating command and control workstations and other hardware.



The dome-shaped Cupola – a room with a view.

ESA's Automated Transfer Vehicle approaching the Space Station.



The Columbus laboratory attached to the ISS.

Portrait of the Expedition 20 crew members. Pictured on the front row are Frank De Winne (left) and Gennady Padalka. On the back row (from left) are: Michael Barratt, Robert Thirsk, Koichi Wakata and Roman Romanenko.

Space-farer with

Frank De Winne previously spent nine days onboard the ISS during his Odissea mission in 2002. Since then, much has changed at the orbital outpost, particularly from a European perspective.

In March 2008, ESA successfully launched Jules Verne, the first Automated Transfer Vehicle (ATV), delivering supplies and hardware the Station.

One month earlier, the European Columbus laboratory was added to the Space Station, at which point Europe became a fully operational ISS partner, with its own permanent orbital infrastructure in which to perform a dedicated scientific research programme.

De Winne is therefore expecting to arrive at a very different orbiting complex to the one he left in 2002.

"First of all it will be a lot bigger – we have the European Columbus module, the Japanese Kibo module and the Harmony node," he said.

"Also, in terms of all the equipment that has been flown up in the meantime it will have changed quite a lot. In particular I think the US segment will be very different though the Russian part will be more or less the same."

For the first four months De Winne will be a flight engineer as a member of the Expedition 20 crew.

Then, with a rotation of three of the six crew members in October, De Winne will become commander of Expedition 21 until his planned return to Earth in November 2009.

Since returning from his first mission to the ISS, De Winne has undertaken additional training on Shuttle, Space Station, and on the European Columbus laboratory and Automated Transfer Vehicle (ATV) systems.

He was also backup to French ESA astronaut Léopold Eyharts who served as an ISS Expedition 16 flight engineer between early February and the end of March 2008.

"The main goals of the new mission are to go from a three person crew to a six person crew, and to see how we can live and work with six person crew – which is going to be quite a challenge in itself," said De Winne.

"The biggest task is to make sure that we can provide all the consumables for the crew and that we can have all the vehicles flying in time - because, if you go from three to six, that means that also your logistics needs to go up by 50 percent.

"Planning for three persons is one thing, but doubling that and making sure that one is not in the way of the other is not so easy," he added.

"For example, when someone is exercising you have to make sure their movement is not influencing a nearby scientific experiment. Everything is packed into small spaces and it means many tasks are inter-dependent.

"For the planning groups on the ground, it is going to be a very big challenge to figure out a smooth-working daily plan every single day."

He says that it will be important for the crew members to maintain "good spirits", not to get in each other's way and make every effort to help each other as much as possible.

"This will all require quite some discipline," he added. "For instance, there are two main ground communication channels onboard the ISS. With three people you almost always have one channel free – but if you are six and only have two communication channels there is a bigger logistical challenge."

Previous crew changeovers were a major task because they had to be handled in a few days before the old crew returned to Earth.

"For us this will not be necessary because the main crew are staying there so they can help us over a longer period," explained De Winne.

"Essentially we will have a four months handover, which is, of course, much better. Initially the main part will

Frank De Winne.

a long-term mission

be to get settled in and to make sure that we know where all the emergency equipment is and all the daily procedures. Then we will prepare for the arrival of the first Space Shuttle mission, because that is scheduled a few weeks after my getting here."

Among many technical highlights for De Winne will be the arrival in September of the first Japanese HTV, which will approach and dock under a very different scenario to ESA's Automated Transfer Vehicle (ATV).

"Whereas the ATV docks automatically, the HTV comes close to the Station, stops and then will be captured and attached to the ISS by the robotic arm. It is a completely different concept," he explained.

"For the HTV the main tasks are basically done by Nicole Stott (who will arrive on STS-128) and myself. She will be the main arm operator and I will be helping her with that."

Overall there will be substantial differences for De Winne between this long-duration mission and his first 11 day flight.

Not the least of these will be a strict daily exercise regime designed to combat the muscle wasting effects of living in conditions of weightlessness for long periods.

"My place of work will also be completely different," explained De Winne. "An 11 day mission could be compared to a 'sprint', every day is fully planned, you know all your tasks very well beforehand, you have rehearsed everything in and out, so you know exactly what day you're going to do what.

"On a six months mission it is totally different. For instance, I have no idea of exactly what I will do on which day. I have, of course, an overall understanding of what I will be doing and which experiments I will be working on but not the daily detail."

He said that the working day will also be very different for a stay of six months. "You certainly cannot work for 14 hours a day or more for six months in a row, it would be impossible."

Referring to his role as ISS commander, which will come towards the end of OasISS, De Winne said: "It is a big responsibility.

"The important thing for me during that period will be to maintain a good team spirit within the crew, ensure that we complete all the tasks given to us by the ground, and maintain a safe environment for the crew to work in.

"And, of course, trying to do a good job so that in the future colleagues of mine, be it from Canada or Japan or ESA, can also get this responsibility.

"My main concern will be to keep a good spirit amongst the crew because you can only accomplish all the tasks if there is a good spirit on board.

"Secondly, if there are emergencies, then the commander is responsible for all the actions taken. Normally the control is with the ground but in an emergency it could be different."

For sometime to come the orbiting Space Station will be the focus of human space exploration, the only space outpost to which we can fly and work on.

De Winne sees the ISS as a stepping stone into the future. "I think it's a big stepping stone to being permanently away from our home planet - first this was with a three person crew, now with six person crew. The next step will probably be a little bit further, like to the Moon and then even further on.

"Low Earth orbit will always be an important destination but we are not doing all this exploration to continue to stay in lower orbit – it will continue to be an important destination but it will not always be the only destination.

"We need to get back to the Moon but with a totally different perspective than when we got to the Moon in 1969 when it was as a race – and the purpose of the race was to be the first.

"This time when we go back to the Moon it will be for a totally different purpose. It will be to go there, to stay there, and to see how we can use the resources of the Moon to benefit life on Earth."

OasISS astronauts Frank De Winne (right) and his backup ESA astronaut André Kuipers.

ESA's Belgian astronaut

Frank De Winne's youthful outward appearance belies a wealth of experience, stemming back to the days when he was regularly at the controls of military fighter aircraft.

De Winne logged more than 2300 hours flying at the controls of Mirage, F16, Jaguar and Tornado high-performance aircraft before joining ESA's European Astronaut Corps in January 2000.

Born in the Belgian city of Ghent in 1961, he originally completed pilot training with the Belgian Air Force in 1986 before becoming an operational pilot on Mirage V aircraft.

As an enthusiastic proponent of space exploration, he is an ideal ambassador for ESA's science and technology projects on the Space Station.

"I will be involved in a variety of educational and public relations activities because it is important to talk directly to our young people – we need to make space, technology and science interesting and relevant to them," he said.

"Very often science is perceived as being dull and hard. But our work can show that it is often quite the opposite – exciting and very worthwhile, not only for the astronauts but also for all of those working very hard back on Earth."

De Winne regards space as having "a big future" for humankind. "I am sure that the children of today will see again people walking on the Moon and maybe going further – and they may even be part of it themselves," he said.

ESA's OasISS mission is also symbolic in that for the first time the crew of six will have representative astronauts from all the partners for a long duration spaceflight.

There will be Japanese (Koichi Wakata), Canadian (Robert Thirsk), European (Frank De Winne), Russians (Gennady Padalka and Roman Romanenko) and US (Michael Barratt) crew members working together.

"I think this is unique and shows the Space Station to be a truly international co-operation," added De Winne. "It demonstrates to the world that if people want to work together – despite all our differences, despite cultural diversity and despite financial problems – then we can accomplish great things."

Behind the scenes

ESA's European Astronaut Centre (EAC) in Cologne, Germany, was established in 1990 to support Europe's commitment to human space programmes.

It is part of ESA's Directorate of Human Spaceflight and is the home base of the 12 European astronauts who are members of the European astronaut corps.

EAC is ESA's principal training centre for both European astronauts and those from the ISS international partner agencies.

The medical team at EAC is dedicated to supporting European astronauts in all areas connected with their physical and psychological well-being.

This means it is involved in all medical decisions from before an astronaut is even selected, throughout their career, right up to and including retirement.

An ESA astronaut doctor – based at EAC – will monitor the health and well-being of Frank De Winne and his fitness and post-flight rehabilitation programmes, coordinating medical issues with the ISS designated crew doctor in the United States.

During the OasISS mission, the Medical Operations Support Centre at EAC in Cologne will provide specific medical support to Frank De Winne and his family.

Essentially, the role of an astronaut doctor is to make sure astronauts stay healthy and are fit enough to carry out their work and experiment programmes, ensuring they receive adequate rest periods, eat properly and stay fit.

The EAC doctors help 'protect' their astronauts against operational demands, defending their interests through the various decision-making processes of a dynamic space mission.

This means monitoring the work, sleeping, and physical fitness schedules, as well as keeping under review the pre-planned programmes designed to minimise the adverse effects of weightlessness on the astronauts' bodies.

Focus on European experiment programme

Frank De Winne tending a plant growth experiment in the Russian Zvezda module of the Space Station during his mission in 2002.

The six month OasISS mission of Frank De Winne will involve a full European experiment programme in a host of different scientific areas, with many utilising the internal and external research facilities of the Columbus laboratory, which was attached to the International Space Station (ISS) as part of a Space Shuttle assembly flight in February 2008.

This research programme will cover different areas including human physiology, biology, fluid and materials sciences and radiation dosimetry.

The experiments will be carried out by ESA astronaut Frank De Winne, other members of the Expedition 20/21 crew and also by visiting members of Soyuz and Space Shuttle flights.

These scientific experiments and technology demonstrations (some of which are summarised below) have come predominantly from scientific institutions across Europe and have been specifically tailored to a long-duration mission on the ISS.

These include experiments that could bring benefits to many Earth-based applications, as well as experiments that are relevant for exploration such as for the development of countermeasures for osteoporosis, the provision of organic-based CO_2 recycling and the development of additional agricultural onboard food resources.

ESA also views education as a valuable component of its human spaceflight missions and Frank De Winne will be the prime focus of ESA's education activities during OasISS.

As well as undertaking a number of live classroom lessons for the ISS, De Winne will be undertaking such activities as a live lesson from the ISS.

He is also a goodwill ambassador for UNICEF Belgium, this provides a great opportunity amongst other education activities during the mission for cooperation between ESA and UNICEF Belgium.

This cooperation will be based on the common ground of water, and in support of UNICEF's water, sanitation and hygiene campaign (WASH). Water is not only one of the most important basic elements of life as we know it and therefore the most important thread to follow when searching for life in the universe but it is also a very important onboard.

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Protein

There is no better place to perform many experiments than in the weightlessness of low Earth orbit on the International Space Station (ISS).

This is where ESA's Columbus laboratory comes into its own, offering scientists the chance to test theories and develop new processes that bring direct benefits back on Earth.

One such investigation currently taking place onboard Columbus is ESA's **Protein** experiment which aims to understand how the conditions in which crystals are grown affects their final crystalline quality.

Without the convection and sedimentation effects induced by Earth's gravity, the experiment will help to understand the fundamental processes that occur during crystallisation by means of sophisticated in-situ optical diagnostics.

Understanding the process of protein crystallisation can help us to obtain better quality crystals, which in turn will help improve their function in various applications – such as in protein-based medicines where they are a means of controlling the release rate of an active compound, or of increasing shelf-life.

The capabilities of telescience allows scientists to monitor and interact with their experiments from a workstation inside the Belgian User Support and Operations Centre.

MOP

This experiment aims at insights into space motion sickness astronauts experience when entering weightlessness. The final goal is to develop effective countermeasures.

Fluid science

The behaviour of foams in the absence of gravity compared to on Earth is very different because the process of 'drainage' does not occur under conditions of weightlessness.

The **Foam Stability** project studies aqueous and non-aqueous foams and the effect/enhancement of the 'foamability' of liquid solutions without gravity's drainage effect.

Among the basic questions being addressed are – how long can those foams be stable? What is the role of solid particles in the liquid in water foam stabilisation? And, is it possible to create very 'wet' foams in weightlessness?

Part of the experiment consists of comparing the results with those of a similar experiment performed by students on the ground.

Material science

The new European-developed **Material Science Laboratory (MSL)** will arrive in August on the ISS together with ESA astronaut Christer Fuglesang on Space Shuttle flight STS-128. **CETSOL** and **MICAST** will be the first European experiments running in MSL. Both experiments look into the microstructures of molten metallic alloys while they are getting solid. **MICAST** aims at the formation of microstructures during casting and **CETSOL** researches into the formation of crystals.

Neurospat

This is the first experiment to fully utilise the Columbus laboratory's **European Physiology Modules Facility (MEEMM)**.

In the first part of the experiment, **Neurocog-2** studies the brain activity that underlies cognitive processes involved in four different tasks that humans and astronauts normally encounter – visuo-motor tracking; perception of self-orientation; 3D navigation; and the discrimination of the orientation of objects.

These tasks are designed to produce changed responses of the sensorimotor system, responsible for the body's coordination and stability, in the presence or absence of gravity. The involvement of five cognitive processes will be examined: perception, attention, memory, decision and action.

In the second part, **Prespat** uses physiological and behavioural measures to assess changes in general activation, prefrontal brain function and perceptual reorganisation. Different measurements will be taken during a spatial orientation task.

Also in the **European Physiology Modules Facility** is **DOSIS (Dose Distribution inside the ISS)** which will determine the nature and distribution of the radiation field inside Columbus.

3D-Space

This physiology study investigates the effects of weightlessness on the mental representation of visual information during and after spaceflight. Runs of the experiment are scheduled for a total of 10 Space Station crew members as test subjects.

WEAR

The **Wearable Augmented Reality (WEAR)** system is a demonstrator to assist astronauts in performing tasks onboard the ISS. **WEAR** allows crew members to consult procedures and manuals hands-free, with relevant information for the assigned task being displayed on a partially see-through screen before the astronaut's eyes. The astronaut will control the system via voice commands.

Solo

The **Solo** experiment is carrying out research into salt retention in space and related human physiology effects. It is a continuation of extensive research into the mechanisms of fluid and salt retention in the body during bed rest and spaceflights and subsequent effect on bone metabolism.

Card

The **Card** experiment involves a series of tests to provide a thorough picture of how the human circulatory system changes during a prolonged stay in weightlessness, in particular looking at the known effects of increased cardiac output and lower blood pressure.

Thermolab

This experiment will investigate thermo-regulatory and cardiovascular adaptations to crew members during rest and exercise in the course of long-term exposure to weightlessness. The idea is to understand more about how the body's heat balance, thermo-regulation and circadian temperature rhythms change during long-term spaceflights.

Lesson-2 and -3

Two live links to primary and secondary school students throughout Europe (Belgium, Spain, Italy and Greece) to give them an appreciation of the conditions of free fall through two simple, curriculum relevant demonstrations, as well as giving them an insight of life onboard the ISS. A t-shirt with a visual graphic element designed by children will be worn by Frank De Winne during the link and a recording will be used to produce ESA multimedia educational material.

Sun studies

ESA's solar payload, located on the **External Payload Facility** of Columbus since February 2008, is mid-way through a two year study of the Sun with unprecedented accuracy across most of its spectral range.

Solar is expected to contribute to the knowledge of the interaction between the solar energy flux and the Earth's atmosphere chemistry and climatology. This will be important for Earth observation predictions. The payload consists of three instruments complementing each other. Solar extreme ultraviolet radiation strongly influences the propagation of electromagnetic signals such as emitted from navigation satellites. Data gathered by **SOL-ACES (Solar Auto-Calibrating Extreme UV-Spectrometer)** will contribute to improving the accuracy of navigation data as well as the orbit forecasts of satellites and debris.

A second experiment, **SOLSPEC (SOLar SPECctral irradiance measurements)** measures solar spectrum irradiances with the aim of accurately studying solar variability over short and long term periods.

ESA's Expose-R experiment on the outside of the Russian segment of the Space Station.

Exobiology

Five exobiology experiments are being conducted on the **European Technology Exposure Facility (EuTEF)** which is also been located on the External Payload Facility of Columbus.

LIFE (Lichens and Fungi Experiment) is testing the survival limits of lichens, fungi and symbionts exposed to outer space; **Adapt** is investigating the molecular adaptation strategies of micro-organisms to different space and planetary UV climate conditions; **PROCESS (PRebiotic Organic ChEmistry on Space Station)** is improving our knowledge of the chemical nature and evolution of organic molecules involved in extraterrestrial environments; **Protect** is looking at the resistance of spores to the open space environment; and **Seeds** is testing the plant seed as a means of transporting life through the universe and as a source of universal UV screens. EuTEF is also home to eight physical and technical experiments, which look into the degradation of materials in space, or the density of the atmosphere 400 km above the Earth.

Expose-R

The **Expose-R** facility – a European external payload attached to the outside of the Russian Zvezda module in March 2009 – houses experiments covering photochemistry, photobiology and astrobiology, and all requiring exposure to the open space environment. **ENDO**, for example, will assess the impact of UV radiation on algae and cyanobacteria from Arctic sites due to ozone depletion.

GTS-2

The **Global Transmission Services (GTS)** experiment has continuously operated on the Russian segment of the ISS since 2000. It is testing the receiving conditions of a time and data signal for dedicated receivers on the ground. The time signal distributed by the **GTS** has special coding to allow the receiver to determine the local time anywhere on the Earth without user intervention.

AIS

An **Automatic Identification System (AIS)** to demonstrate the space-based capability of identification of maritime vessels. The **AIS** antenna assembly will be attached to the outside of Columbus during a spacewalk and two **AIS** receivers – from Norway and Luxemburg – will be stationed inside.

Osteoporosis

A number of ground-based experiments – where the procedures take place before and after the actual mission – are ongoing.

Among them is **EDOS (Early Detection of Osteoporosis in Space)**, a study into the mechanisms underlying the reduction in bone mass, which occurs in astronauts in weightlessness. **EDOS** evaluates the structure of weight and non-weight bearing bones of crew members pre and post-flight together with an analysis of bone biochemical markers in blood samples.

Other ground based experiments are **EKE**, **SPIN**, **Otolith** and **ZAG** which look, for example, into the endurance capacity or the orthostatic tolerance of humans.

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